November 27, 2024

Via electronic submission (http://www.regulations.gov)
Attn: EPA-HQ-OAR-2024-0350
US Environmental Protection Agency

Re: EPA-HQ-OAR-2024-0350; Use of Advanced and Emerging Technologies for Quantification of Annual Facility Methane Emissions Under the Greenhouse Gas Reporting Program

Dear Sir or Madam:

GPA Midstream Association ("GPA") appreciates this opportunity to submit comments on the U.S. Environmental Protection Agency (EPA) Request for information on the use of advanced and emerging technologies for quantification and annual facility methane emissions under the Greenhouse Gas Reporting Program ("GHGRP").

GPA has served the U.S. energy industry since 1921 and has over 60 corporate members that directly employ more than 56,000 employees that are engaged in a wide variety of services that move vital energy products such as natural gas, natural gas liquids ("NGLs"), refined products, and crude oil from production areas to markets across the United States, commonly referred to as "midstream activities." The work of our members indirectly creates or impacts an additional 396,000 jobs across the U.S. economy. GPA members gather over 77% of the natural gas and recover more than 80% of the NGLs such as ethane, propane, butane, and natural gasoline produced in the United States from more than 380 natural gas processing facilities. In the 2019–2021 period, GPA members spent over $100 billion in capital improvements to serve the country's needs for reliable and affordable energy.

GPA believes that existing technologies, as authorized by the New Source Performance Standards ("NSPS") for the identification of "Super Emitter" events, are also acceptable for *finding* potential large sources of emissions. However, these technologies have *not proven to be reliable for quantifying* actual emissions. For this reason, GPA does not believe direct measurement from these technologies should be used to quantify emissions under the GHGRP at this time. Protocols that are working based on measurement-informed inventories (for example, OGMP2.0[1]) also do not suggest that site-level emissions monitoring data from advanced

[1] https://ogmpartnership.com/wp-content/uploads/2023/02/OGMP-2.0-UR-Guidance-document-SG-approved.pdf "Reconciliation is the process of comparing source-level (Level 4) inventories with independent site-level measurements to produce Level 5 asset emissions estimates. Site-level measurements complement - rather than replace - source-level estimates…" "This could also result in a subsequent revision to the [source-level] inventory methodologies and uncertainties to the extent the reconciliation identified under- or over-estimates to one or more specific sources."

technology should be used directly in the inventory. Rather, these protocols point to potential circumstances where a deeper look at emissions may be needed, which ultimately could use a variety of techniques to estimate emissions. GPA believes that there are opportunities to use existing proven technologies such as those provided under the newly revised Subpart W to better manage source specific emission estimations. EPA should allow the recently finalized changes to Subpart W to take full effect before contemplating whether further significant changes to Subpart W are needed. GPA further addresses the rationale for these comments in answering EPA's questions from their request for information below.

General Comments

The midstream oil and gas industry has been at the forefront of the use of alternative technologies to find and fix abnormal emissions, and GPA continues to be supportive of these new technologies. However, quantification of emissions using these same technologies has proven to be challenging across the industry, and even more so at midstream facilities, which tend to be more operationally complex.

The industry is currently about to implement a wide variety of new detection and quantification methodologies that should provide more accurate source-specific emissions rates as a result of changes to Subpart W of the GHGRP. These new allowable measurement methods will help reduce the number of sources that rely on emission factors to estimate greenhouse gas emissions and increase incorporation of measured data. EPA should allow time for these Subpart W changes to be adopted and implemented before making other sweeping changes to the rule.

The GHGRP collects data on all greenhouse gases, not just methane. According to 2023 data reported to the EPA, for all petroleum and natural gas industry segments, carbon dioxide ("CO_2") emissions accounted for 262 MMT CO2e of reported emissions and methane ("CH_4") emissions accounted for 60 MMT CO_2e of reported emissions[2]. Most greenhouse gas emissions are carbon dioxide, which many advanced detection technologies do not measure or quantify. Incorporation of technology must consider how carbon dioxide emissions should be determined, and EPA must consider burden associated with using different methods to estimate emissions of different greenhouse gases for the exact same emissions source. These considerations heavily weigh against expanded use of emerging technologies absent further technological advances.

[2] https://www.epa.gov/system/files/documents/2024-10/subpartw_profile_2023.pdf page 7

Quantification of Annual Methane Emissions Rates

Challenges and considerations for the use of advanced measurement technologies in detection and quantification of methane emission events.

EPA asks what advanced measurement technologies are currently available that can provide quantified methane emission rates using transparent, open-source, and standardized methodologies. GPA is not aware of any measurement technologies that provide transparent, open-source, and standardized methodologies of converting detection to quantified emissions. However, it is GPA's understanding that the translation of detection to quantification is often a key differentiating factor of technology vendor product offerings. As such, that information would not likely be openly shared. It is GPA's understanding that several technologies at least in part utilize a Gaussian plum model in their process/technology.

EPA asks what specific quantification approaches have been used with these technologies, and how have these methodologies been demonstrated and validated. GPA notes that many technologies have been tested at the Methane Emissions Technology Evaluation Center ("METEC"[3]), but the METEC facility (a controlled-release facility in Fort Collins, CO) may be limited in the emissions rates it can test, so testing results may not reflect technology performance for larger releases[4,5]. Stanford has also conducted tests with releases ranging from 1 kg/hr to 1,500 kg/hr[6].

GPA's understanding is that many current aerial, satellite, and stationary sensors have proven that they can identify emissions; however, these technologies have not yet provided consistent accurate quantification in operational studies. Comments below will discuss some of these studies in more detail.

Limitations in the ability of advanced and emerging technologies to quantify emissions are illustrated by a comparisons of the differences in measurements from one company to another. This can be demonstrated comparing each company's calculation methods using the same satellite's emissions data. The information in Table 1 shows emissions rate calculations from

---

[3] https://metec.colostate.edu/

[4] https://energy.colostate.edu/wp-content/uploads/sites/28/2021/03/Survey-Protocol-R0.0.pdf, "The controlled release system at METEC supports emission rates between 0.375 slpm (using the Compressed Gas Association standard conditions of 70°F, 1 atm) to 375 slpm whole gas. This corresponds to a range of 15 g CH_4/hr to 15000 g CH_4/hr assuming gas composition is 100% CH_4."

[5] https://ngi.stanford.edu/sites/ngi/files/media/file/373-6463-1-pb.pdf, "Not all releases could be performed at METEC because some teams reported emissions detection limits that were too large for the emissions capability for the equipment and permitting in place at METEC (see S.I. section 2)."

[6] https://eartharxiv.org/repository/view/5569/ *Comprehensive evaluation of aircraft-based methane sensing for greenhouse gas mitigation*

Carbon Mapper, Kayrros, and the International Methane Emissions Observatory (IMEO) using the NASA EMIT satellite images. Table 1 shows the differences between the company's emission estimates on the same incidents, comparing the minimum and maximum values derived from the three companies' results.

Table 1 Emissions Estimations using NASA EMIT Spectrometer

				Min	max	Difference
Date	Time	lat	long	CH4 t/hr	CH4 t/hr	%
1/29/2023	13:03	-38.745	-68.197	1.90	7.20	117%
2/2/2023	19:38	41.970	-108.293	1.62	3.82	81%
2/3/2023	17:14	34.147	-90.633	10.33	37.56	114%
2/15/2023	20:33	35.264	-97.989	1.69	4.80	96%
12/23/2023	12:30	5.6505	6.5618	2.51	4.12	48%
1/27/2024	19:59	31.844	-101.772	16.60	23.94	36%
2/12/2024	21:48	31.346	-101.797	9.26	18.16	65%
4/5/2024	17:01	38.30	-96.13	16.25	92.36	140%
4/21/2024	18:42	19.567	-92.238	15.99	39.71	85%
6/27/2024	16:07	28.0182	-99.724	1.97	4.70	82%

EPA asks what performance metrics and threshold(s) related to quantification would be appropriate to apply to advanced measurement technologies for their incorporation into the GHGRP. For example, should EPA consider: thresholds for the methane detection limit (e.g., minimum emissions leak rate), thresholds for the probability of detection (e.g., rate of false positives or negative detections), specific levels of accuracy for quantification, specific measurement frequencies, or other?

The answer is yes, EPA would need to consider all these metrics and thresholds thoroughly if mandating the use of advanced measurement technology into the GHGRP, or if EPA provides a voluntary pathway for incorporation of this technology. GPA notes that a significant and thorough scientific review of the entire advanced methane detection space would be needed to provide EPA with necessary additional granularity on this topic.

EPA asks whether quantification approaches should be limited to the use of specific methodologies (e.g., inverse analysis, mass balance) or specific approaches for using ancillary datasets (e.g., standardized interpolation of wind field products)? GPA does not support any form of limitations on acceptable quantification approaches, as GPA supports the ability of technology vendors to continue to develop and evolve new technology and approaches. Any regulatory roadblocks on certain approaches would only serve to limit advancement in methane emission detection, quantification and reduction. GPA does not support any regulatory actions that would hinder advances in this space by prematurely picking winners and losers in methane detection and quantification. Currently, all advanced detection technologies are faced with challenges, especially when moving from emission detection to emission quantification, and "all options" should remain on the table to allow further improvements. GPA notes some of these challenges below, based on research and operational experience of GPA member companies in piloting different technologies.

Six GPA member companies completed a survey about their current deployment of advanced methane monitoring. Most companies were using exclusively aerial surveys, but some respondents indicated limited use of ground based continuous monitoring and satellites.

Satellite

While satellite testing has been conducted, the releases in these studies can be limited; i.e., not rigorous testing over multiple releases with varying rates and weather conditions and are conducted under ideal conditions, which are not representative of typical midstream facilities[7].

Some satellites have low pixel resolution in their imagery and can only indicate emission detections at a facility (such as a gas plant) but are not able to provide more granularity (such as which general area within the gas plant, let alone specific equipment). Another major concern is area source methods that suggest emissions are elevated in a multiple-square-kilometer region and that assume attribution to all sites within the area. This lack of granularity can be acceptable when the technology is used to, for example, identifying pipeline leaks, but it may not be adequate if emissions need to be allocated to individual facilities or individual pieces of equipment within the facility.

Satellites generally traverse the earth north and south and cover a strip of land during the traverse. If detecting emissions along the full strip, most satellites can only achieve high-detection thresholds. Some can achieve thresholds on the order of 200 kg/hr, but many are much higher. To achieve lower detection levels, satellites use "staring mode," which involves pointing satellite sensors at a specific location, such as a gas plant, and maintaining focus on that area for an extended period during the pass. This technique allows the satellite to continuously monitor the emissions from a particular site, rather than just capturing a snapshot as it flies overhead.

[7] https://amt.copernicus.org/articles/17/765/2024/amt-17-765-2024.pdf *Single-blind test of nine methane-sensing satellite systems* "Sample size was modest, with some satellites collecting only one measurement, limiting generalizability of the results without additional data collection." "This experiment was designed to provide nearly optimal conditions for methane-sensing satellites. In addition to the desert background, the site contained only equipment necessary to conduct controlled methane releases and test a suite of methane-sensing technologies. The result is a significantly less complex scene than many oil and gas facilities, which will often contain multiple pieces of infrastructure such as wellheads, tanks, flares, and separators at production sites, as well as entire buildings with sophisticated machinery and piping at compressor stations and gas processing plants. More complex scenery can make methane remote sensing more challenging."

This also supports lower detections thresholds. However, this limits the satellite's capacity to monitor multiple locations, which drives up cost. There may also not be enough existing satellite capacity to support lower detection thresholds at a large number of facilities. Lower detection thresholds would likely be necessary to utilize satellite data in the GHGRP for purposes other than for Other Large Release Events. GPA notes a typical time period from commitment to satellite launch is around 18 months. As such, capacity and cost are current constraints on using satellites at a low enough detection level to incorporate into the GHGRP and methane fee assessment.

Table 1 in the prior section identifies another major issue with the use of satellites for estimating emissions accurately. These estimates rely on proprietary algorithms. These algorithms rely on a variety of inputs, including meteorological data, as well as empirical data used to build the algorithm. Differences in the inputs and assumptions that are used can have a major difference on the estimation of the emissions. The reliability of the assumptions would require further evaluation before use of these technologies should be expanded to methane inventories.

Aerial

The use of aerial platforms for methane detection and quantification presents several challenges and considerations:

Aerial platforms have up to 40% +/- quantification error margin on individual detections, which, while adequate for identifying emission sources for mitigation, is not suitable for creating precise inventories, especially those tied to methane fees. However, it is crucial to avoid EPA regulations that favor specific vendors based solely on accuracy, as that could limit additional technology development or deployment of cost-effective methods to identify large emission sources. Additionally, any protocols need to work with this class of technology, due to wide deployment by operators.

There is also a significant disparity between large and small leaks; the number of leaks detected increases as the detection threshold decreases, but the summation of small sources can be greatly outweighed by one or a few major leaks that drive overall emissions. In other words, a lower detection threshold does not necessarily materially impact the overall measurement-based emission inventory.

Laser-based inspections, although more accurate in pinpointing leaks, are significantly more expensive, while hyper-spectral/infrared (HS/IR) systems, though less precise in location (with a margin of about 5 meters), are better suited for larger leaks and offer a more affordable alternative, albeit with some limitations, such as sensitivity to sun angles and weather conditions, which reduce operational windows and coverage per day. Both detection methods have limitations, particularly with wet dirt and challenging atmospheric conditions. Laser systems provide more precise location data, while HS/IR is more susceptible to weather issues, and neither method accounts for hyper-localized weather conditions such as dust devils, which can distort quantification efforts relying on fixed weather stations.

Airborne surveys only capture a moment in time. EPA needs to fully recognize this to avoid inaccurate emissions assessment with respect to intermittent sources versus continuous emissions.

Capacity is another concern: in general, laser-based systems can only survey one company's assets at a time, whereas HS/IR platforms can cover multiple companies simultaneously by scanning a broader area. However, for lower detection limits (e.g., 10 kg/hr), HS/IR systems would need to fly closer to the ground and could strain the availability of aircraft to meet this demand.

The cost of surveys escalates as detection limits are lowered; lower detection limits may be financially prohibitive for small operators. The survey of six GPA member companies indicated that there can be a wide variety of costs associated with doing these surveys at different detection levels. There was not enough information to tell what was drawing these differences when comparing cost to number of facilities, pipeline miles observed, detection levels, or frequency of survey. This supports the idea that the market is still trying to bear out the price for some of these technologies for the midstream. However lower detection rates did tend to have the higher costs.

Challenges also arise at complex facilities such as gas processing plants, which may have many methane emission sources located in close proximity. For example, engine methane slip can obscure collocated leaks, complicating source attribution. Laser-based systems can accurately pinpoint emissions, whereas HS/IR platforms may require on-site personnel to locate specific leaks. Vertical stacking of pipes and dense facility infrastructure can further complicate aerial detection, as planes cannot easily differentiate leaks within a vertical column. Additionally, plume migration due to wind can lead to overlapping emissions, making it impossible to distinguish between sources once the plumes merge.

Aerial surveys also suffer from some of the accuracy issues that satellites provide due to the models used to estimate emissions. These estimates rely on proprietary algorithms. These algorithms rely on a variety of inputs including meteorological data as well as empirical data used to build the algorithm. Differences in the inputs and assumptions that are used can have a major difference on the estimation of the emissions.

Continuous Sensors

Stationary methane sensors have several challenges and limitations when deployed at midstream oil and gas facilities.

First, while they perform well under ideal weather conditions, their accuracy drops in areas with complex wind patterns. If only one anemometer is available, and the space has swirling winds—potentially caused by building eddies—their reliability decreases significantly. Additionally, all types of sensors face obstacles in detecting leaks when structures like buildings or towers obstruct the path between the emission source and the sensor. This is especially problematic in gas plants, where leaks can occur both high up (e.g., at the top of towers) and near the ground, where structures may interfere with detection. Methane's natural tendency to rise compounds this issue, as emissions from higher points may bypass fenceline monitoring altogether.

Different sensor technologies have varying strengths and weaknesses: for example, metal oxide ("MOX") sensors are relatively cost-effective but degrade over time, causing calibration drift, while tunable diode laser ("TDLS") systems offer better accuracy but can be more expensive and still rely on wind and atmospheric data for quantification, necessitating a per-sensor anemometer. As a result, these systems are currently cost-prohibitive for widespread use.

Furthermore, fixed optical gas imaging (OGI) cameras with quantification, while effective, have a limited range, necessitating numerous units to cover large facilities—up to 20 in some cases.

For all sensor types, a typical gas plant might require 10 to 25 sensors to adequately cover the facility, whereas smaller booster stations may need 4 to 6 sensors. Sensor technologies rely on facility models to attribute detections to emission sources, but there are limitations on the accuracy of these models. This is where the model limitations also plague the accuracy of sensor systems. These systems rely on the same inputs from models that satellites and aerial surveys have. These models are also limited by the accuracy of local meteorological data and assumptions built into the empirical data behind the model development.

Finally, the challenge of reconciling emissions from other nearby facilities is significant. Vendors offering site-wide emissions reports based on measured data, or operators reconciling the data themselves must account for situations where methane plumes from nearby sources drift into a facility's airspace, which can complicate accurate source attribution. These could be other oil and gas facilities or other types of operations with methane emissions. Effective strategies to differentiate between on-site and off-site emissions are critical, especially if the data would be required to be used for regulatory compliance like methane fees.

Extrapolating Quantified Methane Emission Rates to Calculate Annual Emissions for GHGRP Reporting Purposes

At this time, GPA does not support mandatory extrapolation of emissions from the use of alternative technologies that are not continuous. Many of the emission sources identified through individual monitoring events are intermittent in nature, such as a maintenance event. These flows would not be anticipated to last the entire year and can often be difficult to estimate their release times.

Quantifying Annual Methane Emissions from Emissions Sources Below Detection Limits of Advanced Measurement Technologies

Quantification of emissions below detection limits will be an issue for many of the technologies that have higher detection limits. This will be increasingly difficult for facilities in the midstream sector if source-level allocations are used because there are many potential emissions sources with emissions below the detection thresholds of current alternative detection methods. Emission sources, such as fugitive emissions, could have the potential to have small emissions that would not show up on aerial, satellite, or remote sensing technologies. This would be one of the issues with trying to use these technologies at larger facilities as an estimate for emissions for the entire facility.

Attribution

What methodologies are currently available that can attribute quantified methane emissions events to specific equipment using standard methods? Are there specific approaches EPA should consider?

The facilities in the source categories subject to GHGRP vary significantly in size, equipment, and potential emitting activities. Production well pad equipment differs from processing plant and compressor station equipment to an extent that attributing emissions for each facility type could prove difficult, let alone attributing emissions at the equipment or process level. For a typical well pad, emissions will occur from various well venting activities and possibly a nearby storage tank battery. In comparison, for a compressor station, methane slip emissions could occur from a reciprocating engine stack while a blowdown is actively occurring at a nearby compressor and while fugitive leak emissions may be active in-between these two units. This emitting equipment complexity at a compressor station, or a more complex gas processing plant, will make it exceedingly difficult to accurately quantify and attribute emissions at these specific facility types.

GPA does not believe the evidence supports a finding that that currently available advanced methane detection technologies are capable of attributing emissions to just one source at a facility. Lacking this accuracy could result in emissions being counted at more than one source, resulting in over-reporting. This could unnecessarily inflate the emissions from this source category, providing EPA with poor data quality. This overreporting could be due to errors in the model, but also double-counting of emissions from sources that rely on a no-leak emission factor to represent their emissions. These concerns might be further addressed by performing real-world studies, including potential scenarios of typical side-by-side emission sources to better evaluate these technologies' ability to differentiate emitting equipment.

GPA MiDSTREAM ASSOCIATION

GPA does not believe that satellite-based emissions monitoring equipment is currently capable of accurately attributing realistic emissions rates to individual emitting sources within the boundary of a complex midstream facility. GPA agrees that the precision of satellite-based emissions monitors is advancing rapidly and is exhibiting promise for identifying super emitter type events from facilities and pipelines, but it is not ready for pin-pointing these types of events to specific valves, stacks, or even equipment. Satellite-based emissions monitoring equipment on the market today trends toward a methane spatial resolution of greater than 5 m (~16 ft). Therefore, it can be difficult to attribute emissions to one source when this resolution may show emissions in-between two or more activities. We trust this equipment to detect the emissions, but not to accurately quantify them yet.

GPA also notes that it is common to have multiple pipelines owned/operated by different companies in the same right-of-way, and that additional investigation, including excavation, may be needed to determine the source of pipeline leaks.

What accuracy or uncertainty metrics would be appropriate for GHGRP reporting purposes?

Given the potential for double-counting due to the lack of granularity of measurement of currently available methane quantification technologies, and other larger accuracy issues with top-down emission estimates, GPA cannot recommend a specific accuracy or uncertainty metric that would be appropriate for GHGRP reporting purposes. GPA also does not support mandatory use of a particular advanced technology solely based on purported accuracy or uncertainty metrics.

If and when top-down technology is proven to effectively and accurately allocate emissions to specific equipment, the data and research that went into that proof will serve as a basis for establishing metrics.

To what extent would standards and protocols need to be specific to the type of methods and ancillary data used or types of emissions sampled?

Because of the difficulty that will be faced by companies trying to use top-down emissions methods to estimate emissions for individual sources, protocols and standard must be developed to clearly ensure sources captured within a given plume are not double-counted. This will require a complex method of accounting that could require a great deal of additional work for the company responsible for reporting the emissions to ensure the emissions are accounted for accurately. GPA is not aware of a system that has been able to successfully rectify bottom-up and top-down emissions adequately, so this will make developing new protocols and standards very difficult. These issues are further exacerbated by inherent accuracy issues with emissions models.

Implementation

Structure of Approaches or Protocols

As indicated in our comments, GPA does not believe that current advanced methane quantification technologies are capable of providing accurate or reliable annual total, source-specific, methane emissions. Current remote sensing technologies (e.g., satellite, aerial, mobile) only provide a “snap shot” estimate of emissions based on detection during facility “fly over” or “drive by” and may not truly represent actual time-based emissions. As such, current advanced methane quantification technologies are not sufficient to replace traditional bottom-up emissions estimates. However, the advanced methane quantification technology landscape continues to evolve and improve and, as such, may supplement the traditional bottom-up emissions estimates.

GPA encourages EPA to develop standards and protocols that are specific to the “type of method” (e.g., satellite, aircraft, ground based) and instrumentation (e.g., FTIR, TDLAS, LiDAR), as remote sensing technologies are affected by elevation, terrain, wind speed, surface reflectivity, and other variables (dependent on type of method and or instrumentation employed). Due to the variability of factors influencing/affecting the different technologies (instrumentation), it would seem impractical to develop technology-agnostic standards and protocols at this point in time (although that would ultimately be preferred).

GPA believes that the standards and protocols do not need to be source-specific (e.g., tank, pneumatic controller) at present, but could be categorized by large and small methane emissions events. The current advanced methane measurement technologies, even those that can detect/quantify < 1 kg/hour, do not have the ability to identify the specific source of emissions (i.e., pneumatic controller), but are capable of identifying the emissions source to be within a given proximity range (e.g., within 1 meter). Therefore, it is impractical to use the current technology to quantify and develop emissions factors for specific emissions sources (such as valves, pneumatic controllers, thief hatches). Instead, EPA may consider developing protocols/standards that apply to general emissions ranges of < 10 kg/hr, 10-100 kg/hr, and > 100 kg/hr, as these will also have relationship with both type of method and type of instrumentation utilized. These general ranges are not adequate to develop emissions factors, but can help validate or reconcile the bottom-up emissions estimates.

Verification and Validation of Annual Source specific Methane Emissions Quantification Methods Using Advanced Measurement Technologies for GHGRP Reporting Purposes

Informing Methane Emissions Inventories Using Facility Aerial Measurements at Midstream Natural Gas Facilities (Brown et al. n.d.)

GPA has serious concerns with the concept of using advanced measurement technologies to report on GHG emissions. As stated above, these technologies have proven themselves to find emission sources, but there is still a large gap between actual and predicated emission rates.

GPA asks EPA to review "Informing Methane Emissions Inventories Using Facility Aerial Measurements at Midstream Natural Gas Facilities" (Brown et al. n.d.). This paper summarizes a study that "utilized full-facility estimates from two independent top down (TD) methods at 15 midstream facilities, which were compared with a contemporaneous daily inventory assembled by the facility operator, employing comprehensive inventory methods. Estimates from the two TD methods statistically agreed in 2 of 28 paired measurements." Said differently, two generally accepted solutions, a downward looking laser system and a tunable laser spectroscopy sensor flew over the same area conducting simultaneous measurements and only 2 of 28 readings were similar. The readings were not all biased low or high either; they were statistically different. "Solution 1 reporting emissions that were statistically lower than Solution 2 in 20 comparisons and higher in 6 comparisons." The study concluded that, "Significant disagreement was observed at most facilities, both between the two TD methods and between the TD estimates and the operator inventory" and that "the TD full-facility measurement methods need to undergo further testing, characterization and potential improvement specifically tailored for complex midstream facilities."

This paper also mentions a critical phenomenon that continues to be seen during TD emission monitoring at compressor stations: that "emissions may pool or recirculate near large compressor building, possibly complicating or distorting either solution's quantification estimates." Unlike a well pad that generally doesn't have large buildings or structures, compressor stations often have huge buildings that hold the compressors and engines. The observation that emissions could be circulating at a site cannot be downplayed. The alternative measurement technologies often measure in a path integrated concentration (ppm-m). The concentration of methane they report refers to how much methane is present in a column of gas. It's the *summation* of the concentration of the molecules through each measured meter of the column. The study goes on to say, "Winds may recirculate emissions near large structures (where both TD methods estimate emissions), or multiple nearby emission sources may complicate rate recovery algorithms." Compressor station buildings with multiple emission source stacks coming out the top coupled with some wind patterns have shown an emission eddy effect in which the same methane molecule is being monitored over and over again. "The results indicate a need for better-controlled release and field testing of these methods at complex facilities to better characterize TD method uncertainties and a need for MII protocols to consider further assessment and reporting of TD uncertainty."

The conclusion of this report was that "TD estimates are biased high, and the bias is systematic for this facility type". Using advanced technologies to measure or inform inventories is not ready for primetime, especially at midstream facilities.

As noted earlier, wind is a critical component in emission quantification. Since most sites do not have an anemometer, the closest weather center is used to provide the wind data, especially when conducting aerial TD surveys. This data could not only be miles away, but natural features such as being located on hill tops or in valleys can create very different wind rates and patterns that are not captured at central weather stations. This problem will become more evident as the super emitter program is rolled out and third parties are using wind data to attempt to estimate emissions from sources that are not representative of a site's conditions.

Performance of Continuous Emission Monitoring Solutions under a Single-Blind Controlled Testing Protocol (Clay et al., n.d.)

While oil and gas simulation test sites like METEC are valuable, the results often differ in the real world due to conditions that cannot easily be simulated. That's why GPA encourages EPA to understand the limitation around vendor provided test results showing what may be perceived as an acceptable degree of accuracy. Studies such as Performance of Continuous Emission Monitoring Solutions under a Single-Blind Controlled Testing Protocol (Clay et al., n.d.) show that in the real world, quantification of emission rates are all over the place. This study focused on continuous monitors, and came to a similar conclusion as the study discussed above, "The large variability in performance between CM solutions coupled with highly uncertain detection, detection limit and quantification results, indicates that the performance of individual CM solutions should be well understood before relying on results for internal emissions mitigation programs or regulatory reporting."

Another reason that test site results differ from real-world use is that "Ongoing field work indicates solutions deploy different numbers of sensors- typically fewer- in field deployments than were deployed at the test center and often fewer sensors per unit area. This type of change may have substantial impacts on field performance."

This study investigated some of the exact questions EPA is asking here. "There is increasing interest in using CM solutions to quantify emissions at facilities. To simulate this type of deployment, this study performed a Monte Carol (MC) analysis simulating emissions detection and quantification at realistic facilities by using source-level data from Vaughn et al… Results suggest that all solutions considered in the MC analysis would detect less than 87% of sources (If we exclude Solution E, the number drops to 67%), and all but one solution would overestimate total emission for this set of emission sources." Then it goes on to say, "Simulation results suggest that using quantification estimates from CM solutions for measurement-based inventories may substantially misstate both the number of emitters and emission rates."

The study states that "The results presented here indicate that users should utilize CM solutions with caution." For example, most will detect large emitters at high probability, and sooner than survey methods, and will quantify those emitters well enough to inform urgency of a field response. In contrast relying on quantification estimates from these solutions for emissions reporting is likely premature at this point."

This peer reviewed study reinforces GPA's position that the use of advanced technology to determine the quantity of GHG emissions is not ready for primetime, especially when these emissions are being used to determine company waste emission fee payments.

"However, the performance of CM solutions is poorly understood, including their detection limits, quantification accuracy and temporal resolutions all of which are impacted by meteorological conditions, sensor placement and other factors."

GPA appreciates the opportunity to provide feedback on the current quantification accuracy for current technologies available in the oil and gas sectors. GPA believes that these technologies are very useful for identifying methane emissions but are not ready to be used to accurately quantify emissions rates especially for the purposes of GHGRP and waste emission charges. There are additional proven source specific monitoring technologies that GPA would prefer to see implemented to enhance the GHGRP rather than rely on technologies that have not yet been proven to repeatedly show the accuracy that these methods that have been used for the last 15 years have been successful at providing.

These comments should be considered high level reviews of the technologies. Many member companies have collected information using these technologies. Additional time would be needed to collect all of that data.

Sincerely,

Andrew Mooney
Director of Government Affairs
GPA Midstream Association

Brown, J., Harrison, M., Rufael, T., Roman-White, S., Ross, G., George, F., & Zimmerle, D. (n.d.). Informing Methane Emissions Inventories Using Facility Aerial Measurements at Midstream Natural Gas Facilities. *Environmental Science & Technology*. https://doi.org/10.1021/acs.est.3c01321

Bell, C., Ilonze, C., Duggan, A., Zimmerle, D. (n.d.). Performance of Continuous Emission Montioring Solutions under a Single-Blind Controlled Testing Protocol. *Environmental Science & Technology*. *2023, 57, 5794-5805*